THE UNIVERSITY OF ALBERTA

A DEVELOPMENTAL STUDY OF LEARNING UNDER CONDITIONS OF APPETITIVE AND AVERSIVE MOTIVATION

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "A Development Study of Learning Under Conditions of Appetitive and Aversive Motivation" submitted by Mary Courage in partial fulfillment of the requirements for the degree of Master of Science.

TABLE OF CONTENTS

ABSTRACT i

ACKNOWLEDGEMENT iii

LIST OF TABLES iv

LIST OF FIGURES v

INTRODUCTION 1

METHOD

Subjects 13

Design 13

Apparatus 13

Procedure 14

RESULTS

Active conditioning 20

Passive avoidance conditioning 31

DISCUSSION

Active conditioning 38

Passive avoidance conditioning 52

REFERENCES 56

Abstract

The relationship between age and learning ability under two different conditions of motivation was investigated in a 2 x 4 factorial design. Four groups of male, Wistar rats aged 24, 48, 96, and 192 days learned a "light on-light off" discrimination task in a shuttle-box situation under conditions of aversive motivation (shock), and four comparable groups of rats learned the same task under conditions of appetitive motivation (food). Although significant differences were few, the data suggested that within the aversive treatment condition the optimum age for learning was at 96 days of age, followed in rank order by 48, 192, and 24 day old groups. Within the appetitive condition the optimum age for learning appeared to be at the 48 day level, followed by 96, 24, and 192 day old groups, in that order.

Analysis of the motivation main effect showed that Ss performing in the shock groups learned faster at all four age levels than did the Ss performing in the food groups.

In a second phase of the study, rats in the eight groups were given passive avoidance training which consisted of one trial similar to the regular discrimination learning trials except that on this trial all animals received an unavoidable shock in the previously rein-

forced section of the shuttle-box. On the following day the Ss were given one test trial where latency to cross into the previously reinforced section of the shuttle-box was recorded.

An analysis of covariance of these data did not indicate any significant age differences in passive avoidance within either shock or food groups, but on the motivation dimension the appetitive groups showed significantly superior passive avoidance scores as compared to the aversive motivation groups at all age levels. This appetitive group superiority was due to the fact that the aversive groups did not passively avoid at all but showed instead, an enhancement of the original active avoidance response in all but the oldest age group. With respect to both age and motivation the rank order of the passive avoidance scores was, in general, inversely related to the rank order of the original discrimination learning scores.

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Mary Courage

LIST OF TABLES

Number	Title	Page
1.	Mean weights of all Ss on Days 1, 6 and 8, and the percentage weight that each experimental group was of its control group..	16
2.	Group mean speed scores and standard deviations (n=10) based on the mean of Trials 1-23 for each S........................	21
3.	Analysis of variance of Trials 1-23 of the speed score data..............................	22
4.	Duncan's New Multiple Range Test applied to the differences between k=8 means...........	25
5.	Mean daily speed scores for the appetitive and the aversive motivation groups............	26
6.	Group means and standard deviations of speed scores (n=10) for Trial 1 of Days 6 and 8.....................................	32
7.	Summary table of the two analyses of covariance for age effects in the day eight data......................................	34
8.	Summary table of the four analyses of covariance for motivation effects in the day eight data..................................	36

LIST OF FIGURES

Number	Title	Page
1.	Group mean speed scores (n=10) based on the mean of Trials 1-23 for each S........	22
2.	Mean daily speed scores for the appetitive motivation groups.........................	27
3.	Mean daily speed scores for the aversive motivation groups.........................	28
4.	Mean trials to a criterion of three consecutive responses at speeds above 20..	30
5.	Group mean speed scores (n=10) for Trial 1 of Days 6 and 8.........................	33

Introduction

It is an obvious fact among human socities that the adult members of that society "Know more" than do its younger members. However, this increased knowledge with advanced age is not necessarily due to an improvement in learning ability. In fact, in correlation between learning ability and age could even be negative and still allow for a positive correlation between knowledge and age. It is most probable however, that relationship between learning ability and age is curvilinear, with a positive correlation existing for the first and perhaps the middle years of life, and a negative correlation existing thereafter.

The development of learning ability is an important but relatively unknown process, the investigation and understanding of which merits the attention of psychologists, educators, and all those concerned with the course of education today. The results of presently available research suggests that the relationship between learning ability and age is a complex one, and that any investigation which undertakes to map out the dynamics of this relationship and to establish its parameters must necessarily deal with a number of major problems with respect to both the theoretical basis of the research and also the more practical aspects of such studies.

To begin with, "learning ability" is by no means a simple, global construct but may depend on, or develop differentially with such factors as qualitatively different motivations, the nature of the material or task to be learned, the learning history of the organism and, presumably, its age. The difficulties for research arising from these pervasive variables are likely to be magnified as the organism to be studies increases in "complexity", therefore there are some obvious problems confronting the study which used human subjects. For example, one cannot readily investigate learning ability under conditions of aversive motivation using humans. It is also difficult to find a single response suitable to accurately measure learning ability across a wide age range. Neither is it easy to achieve an adequate degree of control over the many factors in the environment that have influenced the processes of learning and education in the individual's past. In view of these practically insurmountable problems, many researchers working in this area have found it preferable to use animal subjects where factors in the environment that influence learning throughout the entire lifespan of the subject can be controlled to an extent that is not possible in the study of human learning.

However, research converned with learning ability as a function of age even on the subhuman level is scanty. Munn, in 1950, concluded a review of the literature on the

rat at that time as follows: "learning ability appears to increase with age up to 30 days, and then remains constant until the rat is about two years old..." (p. 328). However, more recent research in this area suggests that there are many exceptions to this generalization, particularly when motivation is considered. For example, when one looks at the studies using aversive motivation, it appears that rats from 50 to 100 days of age learn better than either younger or older animals.

Thompson, Koenigsberg, and Tenneson (1965) used a shuttle-box situation to condition groups of Sprague-Dawley rats to avoid shock by responding to the onset of a warning buzzer. They reported significantly superior learning in 100 day old animals as compared to 25 and 50 day old groups. Consistent with these results is the data of a study by Denenberg and Kline (1958). They found with black hooded rats, that a group of animals at 60 days of age learned better than groups of either 30 days or 225 days to avoid shock in a shuttle-box by crossing a gate at the sound of a buzzer. However, these group differences were not significant.

Using a similar apparatus, Kirby (1963) conditioned groups of Wistar rats to perform on an electrified runway. The task consisted of running to the safety of a goal box at the sound of a warning buzzer. He found that

rats at 50 days of age ran nonsignificantly faster than either 25 or 100 day old Ss. However, when the number of correct avoidances was the criterion for learning there were no significant differences between the three groups, although the rank order of learning was the same as before. Although these results are partially opposed to those reported by Thompson et al (1965), they still support the general hypothesis that the optimum age for learning under conditions of aversive motivation is somewhere between 50 and 100 days of age. A second experiment in the same report (Kirby, 1963) added more groups to the design, and still achieved the same results as had been previously obtained i.e., the best performance was shown by animals at 50 days of age, followed by rats of 125, 150, 25, 75, and 100 days. However, there were no significant differences in this study.

Doty (1966) studied the performance of Long-Evans rats on two similar, "light on-light off" discrimination tasks. On the first task Ss had to avoid shock in a shuttle-box situation by responding to a warning light that preceeded the shock. She found non-significantly superior performance in rats at 50 days of age as compared to animals of 25, 450, 250, or 650 days old. On the second task, in which the rats were delayed by a plexiglass screen for five seconds before they could make the avoidance response, she found that the very young and the extremely old animals showed significantly

poorer performance under the delayed avoidance condition than animals in the 50, 250 and 450 day old groups, these latter three not differing significantly. Doty stressed the importance of considering the nature of the required task in studies of this kind. However, she also mentioned that her animals were not handled at all prior to the study in which they weretto take part. It would seem that this could be an important factor in the explanation of her results, particularly in the case of the older animals who may have found the experimental situation somewhat traumatic.

Birren (1962) tested groups of Sprague-Dawley rats in a two choice water maze and found that animals at 100 days of age made significantly fewer errors as compared to groups at either 450 or 750 days old.

Along the same line, although using only very young rats, Biel (1940) found significantly superior differences in the water maze performance, as measured by both time to swim the maze and the number of errors made, in a 29 day old group of albino rats as compared to 16, 19, or 22 day old animals.

On the basis of the above studies, all of which use aversive motivation in one form or another, it seems that the optimum age for learning based on aversive motivation for Wistar, Sprague-Dawley, black hooded, and Long-Evans rats performing in mazes, shuttle-boxes, and on discrimination problems is probably between the ages of 50 and 100 days old, with both younger and older animals performing less well on the required task.

In studies using appetitive motivation, although it is more difficult to make a generalization, it appears that younger animals tend to perform better on learning tasks than do older animals. For example, in studying maze learning, Hubbert (1915) found that the quality of performance, in terms of the fewest number of trials to the criterion, was highest in her group of 25 day old rats followed in rank order by 65, 500, 300, and 200 day old groups. When speed of learning the maze was taken as the criterion for learning, the 65 day old animals performed the best followed by 25, 200, 500 and 300 day old rats.

Other work with maze learning was done by Stone (1928a; 1928b) who did a comprehensive series of studies on the relationship between age and learning ability in albino rats, under conditions of appetitive motivation. He tested rats at the developmental stages of infancy (20-25 days), early pubescence (50 days), late pubescence (70 days), young adulthood (120 days), middle age (240 days), and senescence (730 days), on several forms of the Carr Maze, the Triple Platform Maze, multiple light discriminations, and in a complex T-m aze. In addition, the animals were run under conditions of strong, moderate, and weak motivation. He concluded that in general, in the absence of interfering habits, the approximate maximum learning rate for mazes, problem boxes, and light discimination tasks, is attained by young animals between the ages of 30 and 75 days, probably closer to the former than to the latter. He added that the

maximum learning rate does not decline in normal, healthy animals during the first two years of life. He also found that superior performance on the various tasks was shown by the strongly motivated groups as compared to those rats learning under moderate or weak drive states. Stone's conclusions are tentatively drawn because the work was done in the absence of the normative information which he felt was needed to equate motivational strength and to control for differential growth rates at the various age levels.

In the area of discrimination learning, Fields (1953) tested groups of Sprague-Dawley rats at three different ages on a series of five choice complex, shape discrimination problems. One group was tested at 30, 60 and 90 days of age and a second group was tested at 450, 480, and 510 days of age. He found no significant differences in the final level of accuracy of discrimination reached by the groups, but the older animals were, in general, significantly slower in reaching the criterion than were the younger animals. He concluded that old rats suffer a decrement in the intellectual ability necessary to solve complex discrimination problems. However, this explanation was not born out by the work of Oldfield-Box and Key (1963) who found the reverse to be true. Using four choice, complex discrimination problems, similar to those used by Fields, they found that a group of 360 day old animals learned the problems to a criterion of 75% correct choices better than groups of 240-270 and

95-150 day old animals. However, these differences were not significant.

The Fields (1953) results were supported in a study by Sime and Key (1962) who found that hooded rats between 150 and 180 days of age learned a "cross versus square" shape discrimination task significantly better than rats of between 450 and 480 days of age. However, these authors found that their results were reversed when the position of the figures, i.e., high or low, became the relevant cue for learning, with groups of old rats learning the discrimination better than the younger animals. They offer in explanation the idea that old animals suffer a loss, not of behavioral plasticity, but of sensory capacity, i.e., old animals are less well equipped visually to abstract the cue "shape" from a stimulus array. Such a visual handicap in these animals is more likely to effect their performance on a "shape" rather than on a "position" discrimination task.

However, since the same Sslearned first the shape and then the position discrimination tasks, it is probably that since the younger group had initially learned the "cross versus square" discrimination better than the older group, they would also have retained the cues relevant to the shape discrimination task better than the older groups, and this would have interfered with the later learning of the position discrimination.

The results of another study by Key and Sime (1962), showed that hooded rats of 540-600 days of age made non-significantly fewer errors on a shape discrimination task than animals between 150 and 180 days of age. The explanation they offered in their previous study would not seem to apply in this case, however. It should also be noted that these authors allowed their animals three hours of free feeding time per day, which would not induce a very strong motivational state in the rats.

Further work on discrimination learning under conditions of appetitive motivation was done by Liu (1928) who found that best performance was shown by animals between 75 and 100 days. The performance of 30, 45, and 60 day old groups increased up to this optimum age and declined thereafter in groups of 150 and 250 daysold animals. The pattern of these results fits in well with the findings of the aversive motivation studies as well as lending some degree of support to the appetitive motivation hypothesis.

One study, by Solyom and Miller (1965), examines both aversive and appetitive motivation within a single study. They compared the development of the acquisition of an operant response and a classically conditioned emotional response (a CER) in two groups of Wistar rats, one between the ages of 150 and 180 days, and a second group at 600 days of age. They found that the younger group acquired the response significantly more quickly, and bar pressed more frequently (bar pressing being considered as the measure of

acquisition), than the older animals during both the variable interval and CER training.

It would appear then, that in studies using aversive motivation, there is a curvilinear relationship between age and learning ability as measured by performance on various tasks, with learning ability improving with age up to about 50 to 100 days and then declining as the animal reaches middle and old age. On the other hand, under conditions of appetitive motivation, although the results are by no means clear-cut in their support of this generalization, learning ability seems to be greatest in young animals and to decrease with advancing age.

Apart from the study by Solyom and Miller (1965), there does not appear to be any single study which compares the development of learning ability under conditions of both aversive and appetitive motivation, and there are none comparing the development of the same response under both drive states. This study attempted to make such a comparison, holding the strain of animal, experimenter, and response topography constant. A factorial design was used with aversive and appetitive motivation as one factor, and four different age levels as the second factor, i.e., 24, 48, 96, and 192 day old animals, thus giving infant, adolescent, young adult, and old adult groups of albino rats.

This study also lent itself to a possible interpretation in terms of Schneirla's Approach-Withdrawal theory (Schneirla 1959). According to this theory, "in all animals,

the species typical pattern of behavior is based on biphasic, functionally opposed mechanisms insuring approach or withdrawal reactions according to whether stimuli of low or high intensity are in effect" (p.4)

For all animals in the early ontogenetic stages, low intensities of stimulation tend to evoke approach reactions, and high intensities of stimulation withdrawal reactions, with reference to the source. Thus in the early stages of development, quantitative aspects of the stimulus dominate both the direction and vigor of the action.

As development progresses, higher mammals tend to deviate from this simple, intensity-based determination of approach and withdrawal responses. Through experience, approach and withdrawal processes become cued to specific extrinsic stimuli, and the organism learns to deal with the evironment in qualitative terms, i.e., the animal can distinguish qualitative differences between stimuli, and can act accordingly. Thus the early, simple approach and withdrawal behaviors that are a function of stimulus intensity will become differentiated into operations of seeking and avoidance, respectively, at this later stage of development.

Schneirla has suggested that the seeking patterns are are mastered out of approach behaviors by young animals before withdrawal reactions have begun to differentiate into avoidances. If this idea is correct, there would be some reason to expect that in a group of young animals (for example 24 days old), performance on a learning task under

conditions of appetitive motivation would be superior to the performance of a comparable group of animals learning the same task under conditions of aversive motivation.

On the basis of the literature review of the studies dealing with learning ability as a function of age, and on the basis of Schneirla's theoretical position on the development of seeking and avoiding responses, a number of expectations as to the outcome of this study were stated.

It was predicted that under conditions of aversive motivation, learning, as measured by response speed, should occur in the following rank order of superiority: 96 days, 48 days, 192 days, 24 days. Under conditions of appetitive motivation, learning, as measured by response speed, should occur in the following rank order of superiority: 24 days, 48 days, 96 days, 192 days.

Differences in performance between aversive and appetitive groups at each age level should be as follows: at 24 days of age, animals in the appetitive treatment condition should be significantly superior to animals in the aversive motivation group. At 48 days of age and at 96 days of age aversive and appetitive groups should perform similarly. At 192 days of age the aversive motivation groups should be significantly superior to the appetitive motivation group.

Method

Subjects

80 male Wistar rats were the subjects in this study. There were 20 animals in each of four different age groups, i.e., 24, 48, 96, and 192 days of age at the beginning of the experiment.

Design

A 2 x 4 factorial design was used in this study. The first factor consisted of the different age groupings, and the second factor consisted of either appetitive (AP) or aversive (AV) motivation. This arrangement yielded eight groups which have been designated as 24AP, 24AV, 48AP, 48AV, 96AP, 96AV, 192AP, and 192AV.

Apparatus

A 6½ x 8 x 20 in. shuttle-box divided into two compartments by a 6½ x 8 in. hand operated, guillotine door was used to condition the animals. Three walls of the left hand side (side one) of the apparatus were painted in flat black, and three walls of the right hand side (side two) of the apparatus were painted in flat white. The front and top of the box were constructed from clear plexiglass. A six watt bulb was located in the end wall of side one. This bulb could either be turned on and off automatically by the action of the opening and closing of the guillotine door, or could be

operated manually.

The floor of the shuttle-box was a grid of one-eighth inch copper rods spaced one half inch apart. The grid could be charged in both compartments with a current of approximately .5 ma from a C.J. Applegate stimulator (Model 228) through a grid scrambler.

Latencies were timed automatically by a Lafayette timer which could be started either manually or by the action of the opening door as it brushed a controlling microswitch, and was stopped by the animal's crossing a photoelectric beam, located approximately three inches into side two of the apparatus.

A pre-training apparatus was used to acquaint the appetitive group Ss with the .045 gm. Noyes pellets which were to be used as reward. It consisted of a 5 x 6½ x 55 in. wooden box which was divided into five equal sections 11 x 5 x 6½ in. by panels of clear plexiglass. The floor and walls of the box were painted in flat grey and the top was made of plexiglass. Three animals were run at one time in this apparatus, one in each of the end compartments and a third in the middle compartment.

Procedure

Pre-training. All Sswere individually housed and adapted to a 12 hour light/dark cycle. They were handled daily and adjusted to the appropriate food deprivation schedules. Animals that had been randomly assigned to the

appetitive motivation groups were put on a deprivation schedule that allowed them the following quantities of Purina Lab Chow (powdered) per day: 24AP 10gm., 48AP 8gm., 96AP 7gm., 192AP 5gm. These quantities had been determined previously during a pilot study as the amounts necessary to strongly motivate the Ss to perform the required task. Determining the correct deprivation schedules presented a problem since there were no available growth norms which would have aided in establishing some control for the probably unequal food motivation during the periods of differential growth at the different age levels. All Ss were given water ad libitum.

Ss that had been randomly assigned to the aversive motivation groups were placed on food deprivation schedules that allowed them approximately twice as much food per day as their appetitive group counterparts.

At each age level a pair of animals was kept on an ad libitum feeding schedule and weighed daily so that the normal weight of the animals at that age could be determined and compared to the weight of the experimental animals during the course of the study. The record of this information is presented in Table 1. The most important fact that emerged from this data was that the experimental animals were not all at the same percentage of the weight of their respective control animals.

After the groups had been adjusted to their feeding schedules, there were two sessions, 24 hours apart, in which

TABLE 1

Mean weights of all Ss on Days 1, 6 and 8, and the percentage weight that each experimental group was of its control group.

Group	Day 1 Weight	Day 1 % of Control	Day 6 Weight	Day 6 % of Control	Day 8 Weight	Day 8 % of Control
24 AP	57.2	92.3	68.9	80.1	74.4	71.3
24 AV	66.4	107.1	87.8	102.0	65.9	64.0
Control	62.0		86.0		103.0	
48 AP	138.1	89.7	138.1	71.7	140.4	65.6
48 AV	140.9	91.5	159.5	82.9	167.6	78.3
Control	154.0		192.5		214.0	
96 AP	260.3	98.6	241.7	82.2	263.5	77.0
96 AV	259.7	98.4	253.7	89.7	257.3	83.8
Control	267.0		294.0		307.0	
192 AP	425.7	78.0	404.9	73.8	395.1	72.2
192 AV	472.5	86.2	465.6	84.8	460.2	84.1
Control	545.5		549.0		547.5	

_S_s to be run in the appetitive motivation groups were placed in the pre-training box and given four of the reward pellets per session. Animals that had been assigned to the aversive motivation groups were similarly placed in the box, but were not given any of the pellets. They were left in the apparatus for a period of two minutes and then removed to their home cages.

Training. Conditioning of the _S_s proceeded as follows:

Aversive Motivation.

Day 1. The animals were given three trials. On Trial 1 rats in the shock groups were placed in side one (shock) of the apparatus with the escape door closed. The light was manually switched on for five seconds after which time the shock came on. After five seconds of shock and ten seconds of light, the escape door was opened and the time it took the animals to move into side two and safety was recorded. The regular active conditioning trials began on Trial 2. On this trial and on Trial 3 the _S_s were again placed in side one of the apparatus. After an interval which varied between two and ten seconds, the escape door opened and the light came on simultaneously. After five seconds had elapsed the animals received continuous shock if they had not crossed into the safety of side two by this time. Latencies in crossing from side one to two side were recorded automatically. The animal was removed immediately from side two of the apparatus and placed in his home cage.

Appetitive Motivation.

Animals which had been assigned to this treatment condition were also given three trials on Day 1. On the first trial the S was placed in side one of the apparatus with the guillotine door closed. The light was switched on for ten seconds after which time the door was opened and the animal could move into side two of the apparatus.where two food pellets were available. The latency to cross from sides one to two was recorded. The regular active conditioning trials began on Trial 2. On this trial and on Trial 3 the S was again placed in side one of the apparatus, and after an interval which varied between two and ten seconds the door opened and the light came on simultaneously. There were two food pellets available in side two on each trial. The animal was removed from the apparatus as soon as he had eaten the pellets and returned to his home cage.

Days 2 to 6. All Ss in both motivation conditions were given four regular active conditioning trials per day. Thus, each animal had received a total of 23 trials by the end of Day 6.

Passive Avoidance Training. This phase of the study began on Day 7 as follows:

Day 7. Each animal was given one regular active conditioning trial as on Day 6. Trial 2 for all animals was as this first trial until the S had entered side two of the box, at which time the escape door was closed, the light went off, and the animal was given two seconds of shock from which he could not escape. After the two seconds the door was opened

and the animal was allowed to escape into the safety of side one, although shock was still continuing in side two. The S was then quietly removed from side one of the box and returned to his home cage.

Day 8. Only one trial was given on this day. The animal was placed in side one of the shuttle-box and treated as on a regular active conditioning trial except that no shock was administered to Ss in the aversive motivation groups. Time to cross into side two was recorded. If the rat had not crossed into side two after 120 seconds had elapsed, he was removed from the apparatus and placed in his home cage.

Results

Active Conditioning

Group mean speed scores and standard deviations (n=10) based on the sum of Trials 1-23 for each S in each of the eight experimental groups are shown in Table 2. The group means which are also graphically represented in Figure 1, indicate that the Ss who learned the task under condition of aversive motivation performed faster, i.e., had higher mean speed scores at all four age levels, than did Ss who learned the same task under conditions of appetitive motivation. These data further show that within the aversive motivation treatment the 96 day old animals performed the task with the greatest speed, followed in rank order by 48, 192, and 24 day old Ss. In the appetitive motivation treatment the 48 day old animals showed the highest performance scores, followed by the 96, 24, and 192 day old Ss, in that order.

The results of an analysis of variance for repeated measures on these data (see Table 3) show that both of the principal main effects, i.e., age and motivation, were significant, (F=17.84, df=1/72, p <.05; F=4.57, df=3/72, p <.01, respectively). However, the Age x Motivation interaction was not significant.

Further analysis of the data was carried out to determine exactly where these significant differences lay with respect

TABLE 2

Group mean speed scores and standard deviations (n=10) based on the mean of Trials 1-23 for each S.

Group	Mean	Standard Deviation	Group	Mean	Standard Deviation
24 AP	25.77	21.91	24 AV	31.44	25.08
48 AP	43.72	57.57	48 AV	64.99	92.47
96 AP	37.91	47.82	96 AV	97.53	112.73
192 AP	21.94	38.84	192 AV	62.61	80.61

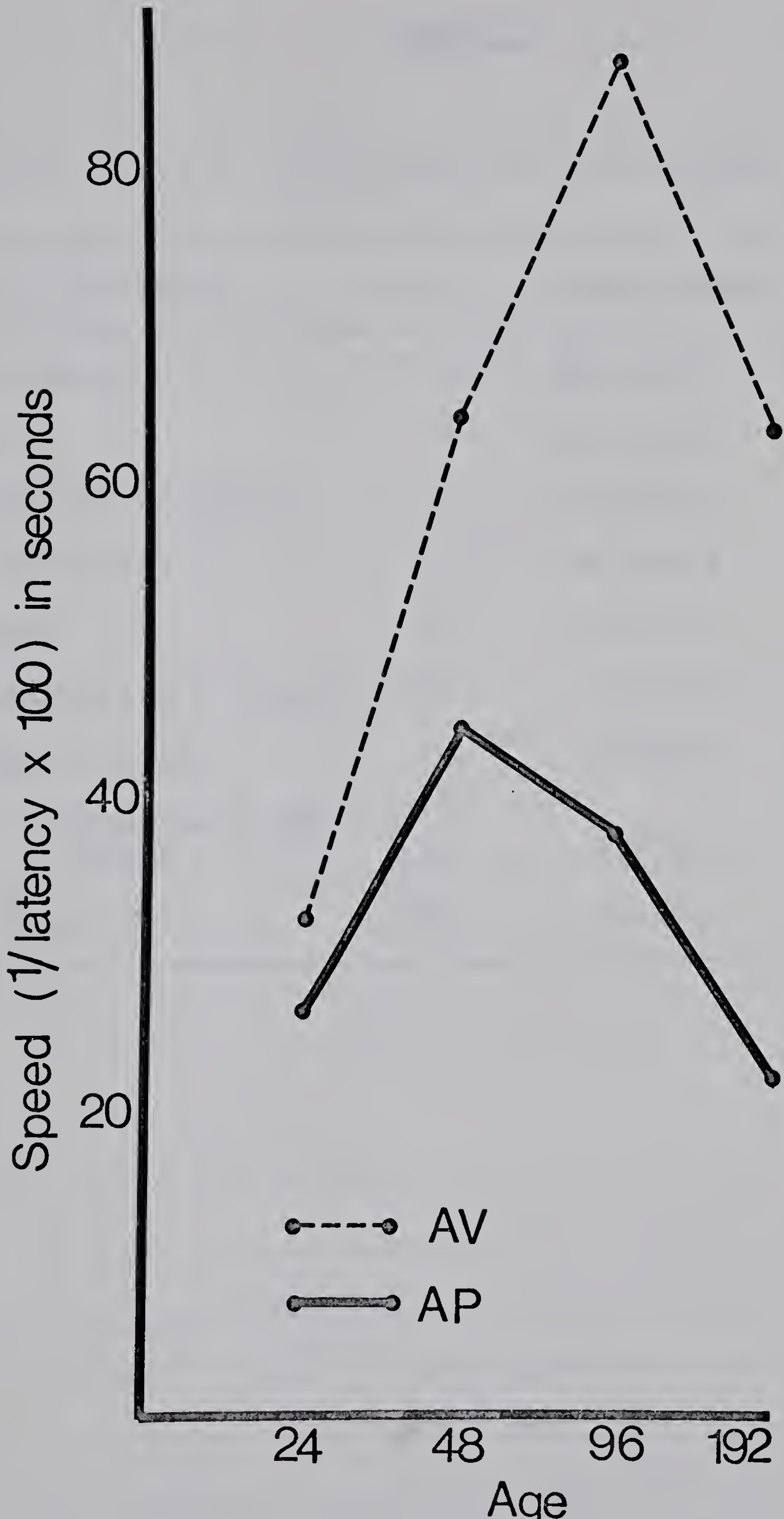


Fig.1. Group mean speed scores (n=10) based on the mean of Trials 1-23 for each $\underline{S}$.

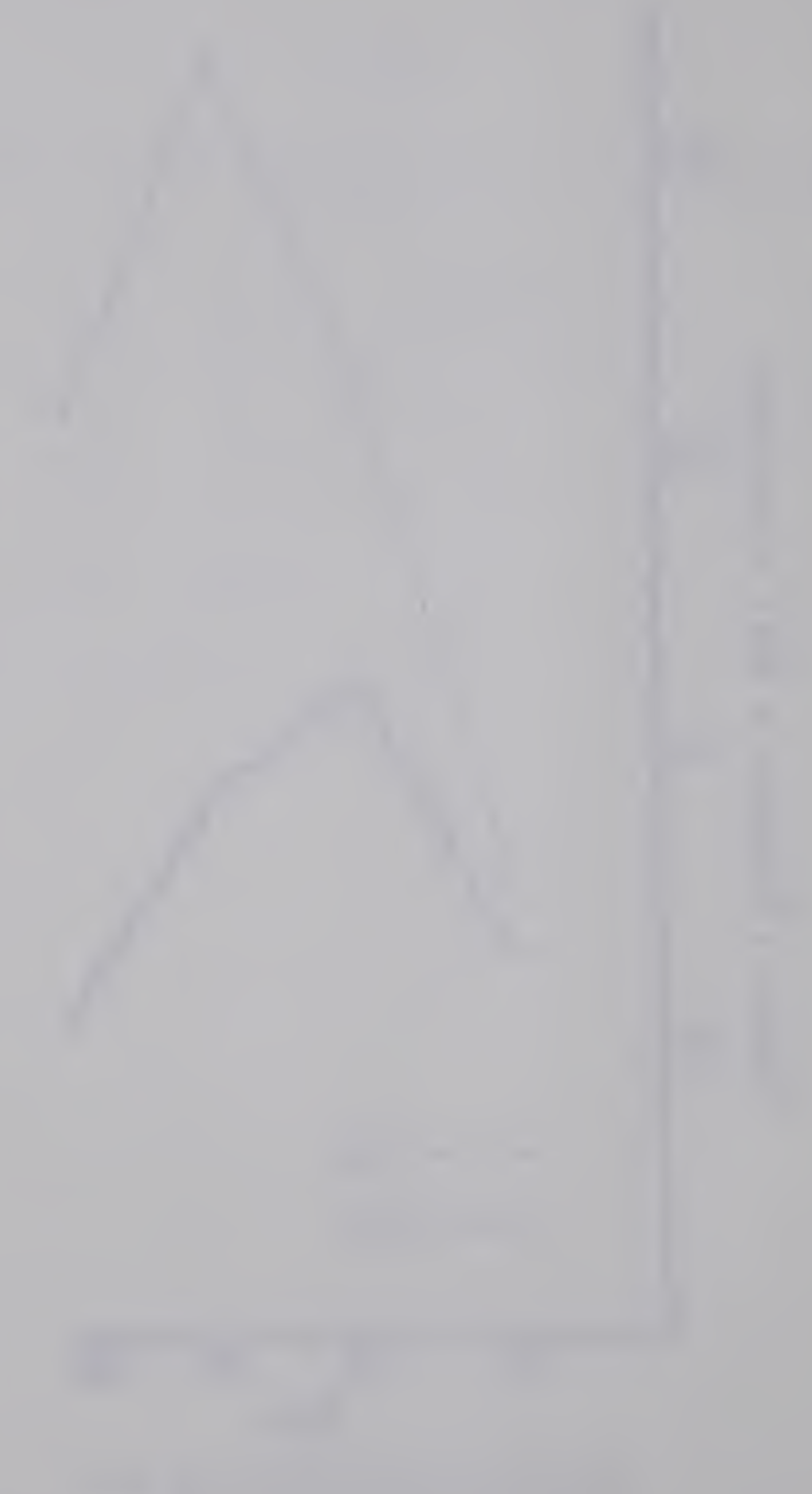


TABLE 3

Analysis of variance of Trials 1-23 of the speed score data.

Source of Variation	d.f.	Mean Square	F	P
A: Motivation	1	359,251.2	17.84	<.01
B: Age	3	101,527.9	4.57	<.05
AxB: Age x Motivation	3	28,200.7	1.27	N.S.
Error (a)	72	22,199.5		
C: Trials	22	49,477.3	15.88	<.01
AxC: Motivation x Trials	22	4,851.0	1.57	<.05
BxC: Age x Trials	66	4,853.3	1.56	<.01
AXBXC: Motivation x Age x Trials	66	3,779.8	1.20	N.S.
Error (b)	1584	3,114.2		

to comparisons of the individual group means. For this purpose Duncan's New Multiple Range Test was applied to the data (see Table 4). With respect to the age main effect, the only significant differences of interest to the present study were in the aversive motivation treatment, where the 24 day old animals were inferior to the three older groups ($p < .05$). However, none of the other differences within this treatment condition reached an appropriate level of significance. There were no significant differences within the appetitive motivation groups.

Although previous examination of the motivation main effect had suggested that the Ss who performed the task under conditions of aversive motivation did so faster than those Ss who performed the same task under conditions of appetitive motivation, according to Duncan's test only the differences between 96 day old aversive and appetitive groups and 192 day old aversive and appetitive groups were significant ($p < .05$).

Mean daily speed scores for the three trials given on Day 1, and for the four trials given on each of the following five days, are presented for all groups in Table 5 and in Figures 2 and 3. Figure 2 representing the appetitive groups, shows that on Days 1 and 2 of conditioning the four age groups were performing similarly, with more pronounced differences becoming increasingly apparent on the four subsequent days, at which time the 48 day old animals show

TABLE 4

Duncan's New Multiple Range Test applied to the differences between k=8 means.

192AP 21.92	24AP 25.77	24AV 31.44	96AP 37.91	48AP 43.72	192AV 62.61	48AV 64.99	96AV 87.53	Shortest Significant Ranges	
	3.85	9.52	15.99	21.80	40.69	43.07	65.61	R_2-	27.73
		5.67	12.14	17.95	36.84	39.22	61.76	R_3-	29.20
			6.47	12.28	31.17	33.55	56.09	R_4-	30.09
				5.81	24.70	27.08	49.62	R_5-	30.77
					18.89	21.27	43.81	R_6-	31.36
						2.38	24.92	R_7-	31.75
							22.52	R_8-	32.14

TABLE 5

Mean daily speed scores for the appetitive and the aversive motivation groups.

Group	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
24AP	12.98	17.65	23.37	20.32	33.20	43.86
48AP	6.71	11.44	17.66	46.00	70.80	100.34
96AP	15.15	15.90	19.98	33.64	63.17	73.88
192AP	10.38	8.36	6.95	21.68	30.34	50.76
24AV	16.86	19.53	27.64	31.45	36.52	53.64
48AV	14.02	28.36	47.50	72.05	106.78	104.46
96AV	15.50	34.35	96.26	105.53	114.11	140.29
192AV	14.38	45.10	57.15	68.89	84.94	92.94

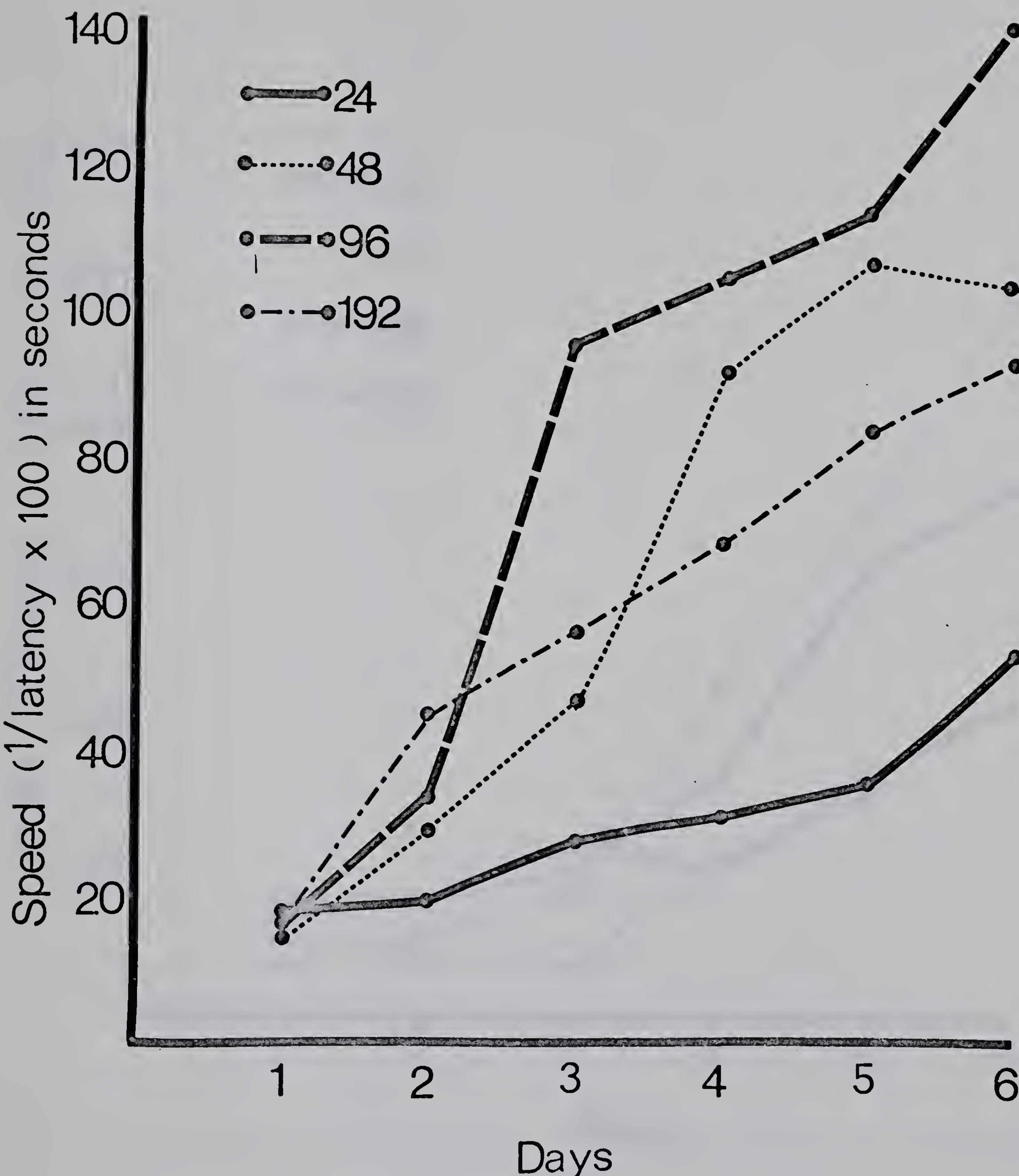
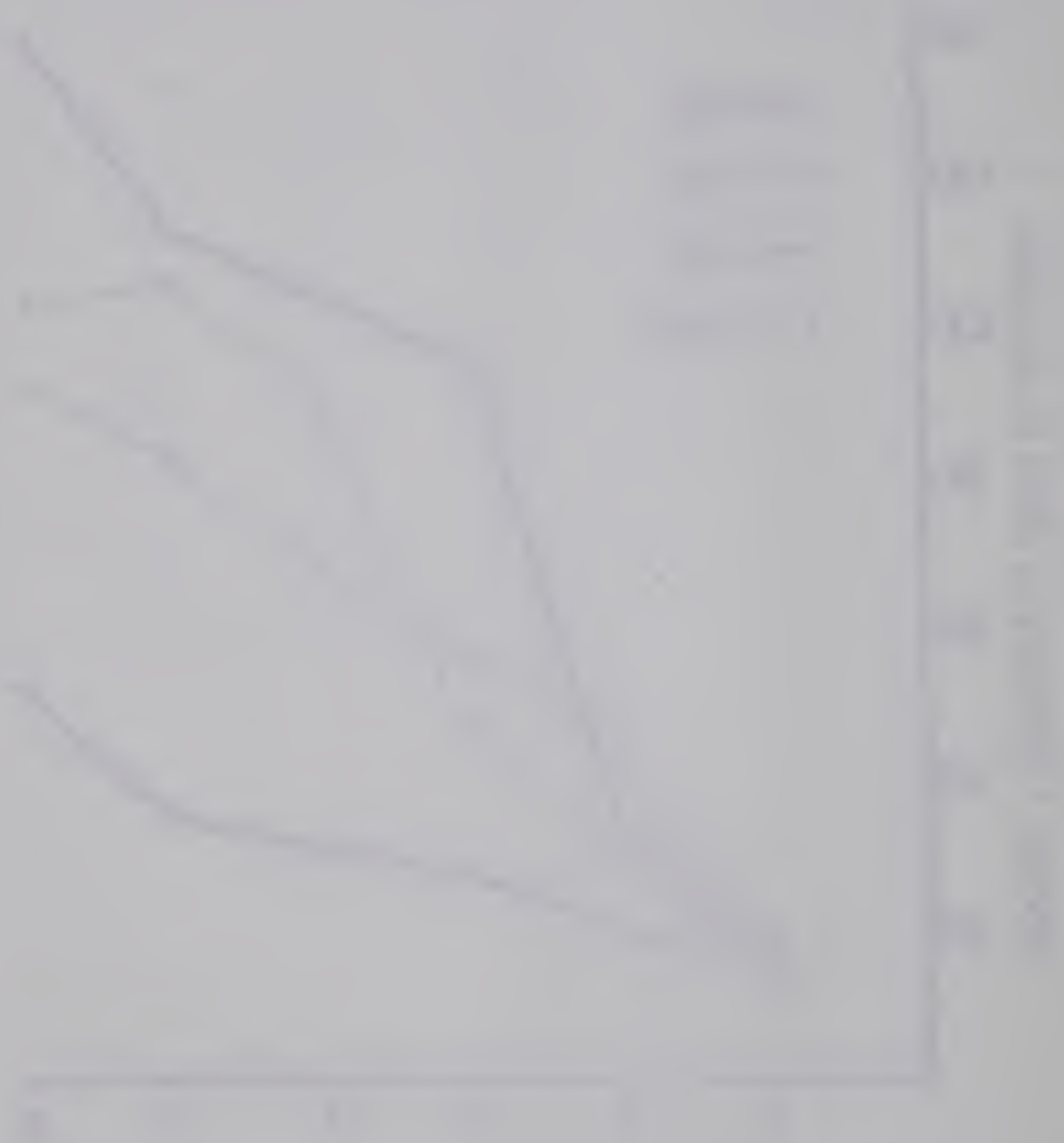


Fig.2. Mean daily speed scores for the appetitive motivation groups.



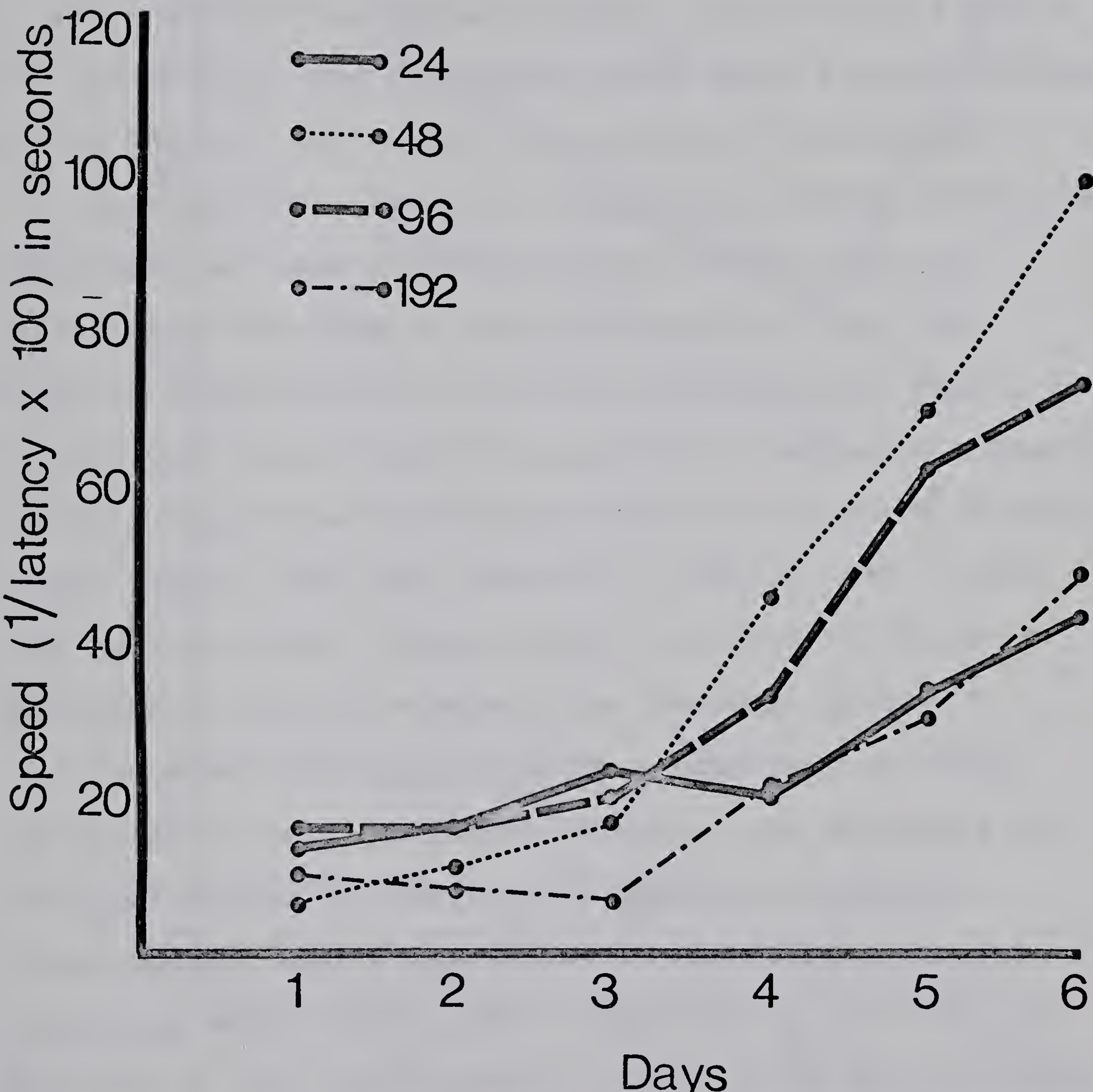


Fig.3. Mean daily speed scores for the aversive motivation groups.

the highest mean speed scores, followed by the 96, and the intertwined 24 and 192 day old groups. Figure 3, showing the aversive motivation groups, indicates that age differences in performance become marked after Day 1 and continues to be so on the five following days, until by Day 6 the 96 day old animals show the highest mean speed scores, followed by the 48, 192, and 24 day old animals, in that order.

An attempt to locate the significant simple effects in the significant Age x Trials and Motivation x Trials interactions was made by applying Scheffe's Test for Multiple Comparisons to the Trial Blocks data of Days 1 to 6 in both the aversive and the appetitive treatments. However, the only significant differences were as follows: on Trial Blocks 5 and 6 96AV was superior to 24AV (p .05). There were no significant simple effects on the Trial Block performance within the appetitive treatment groups.

The mean number of trials to a criterion of three consecutive correct avoidance responses are presented for the eight groups in Figure 4. Although an analysis of variance of these data indicated significant Age and Motivation main effects (F=4.11, df=3/72, p <.01; F=7.78, df= 1/72, p <.01 respectively), Duncan's New Multiple Range Test applied to the group means indicated that while 96AP was significantly superior to 192AP (p <.05), this was the only significant age difference of interest to the study. There were no significant differences between the groups on

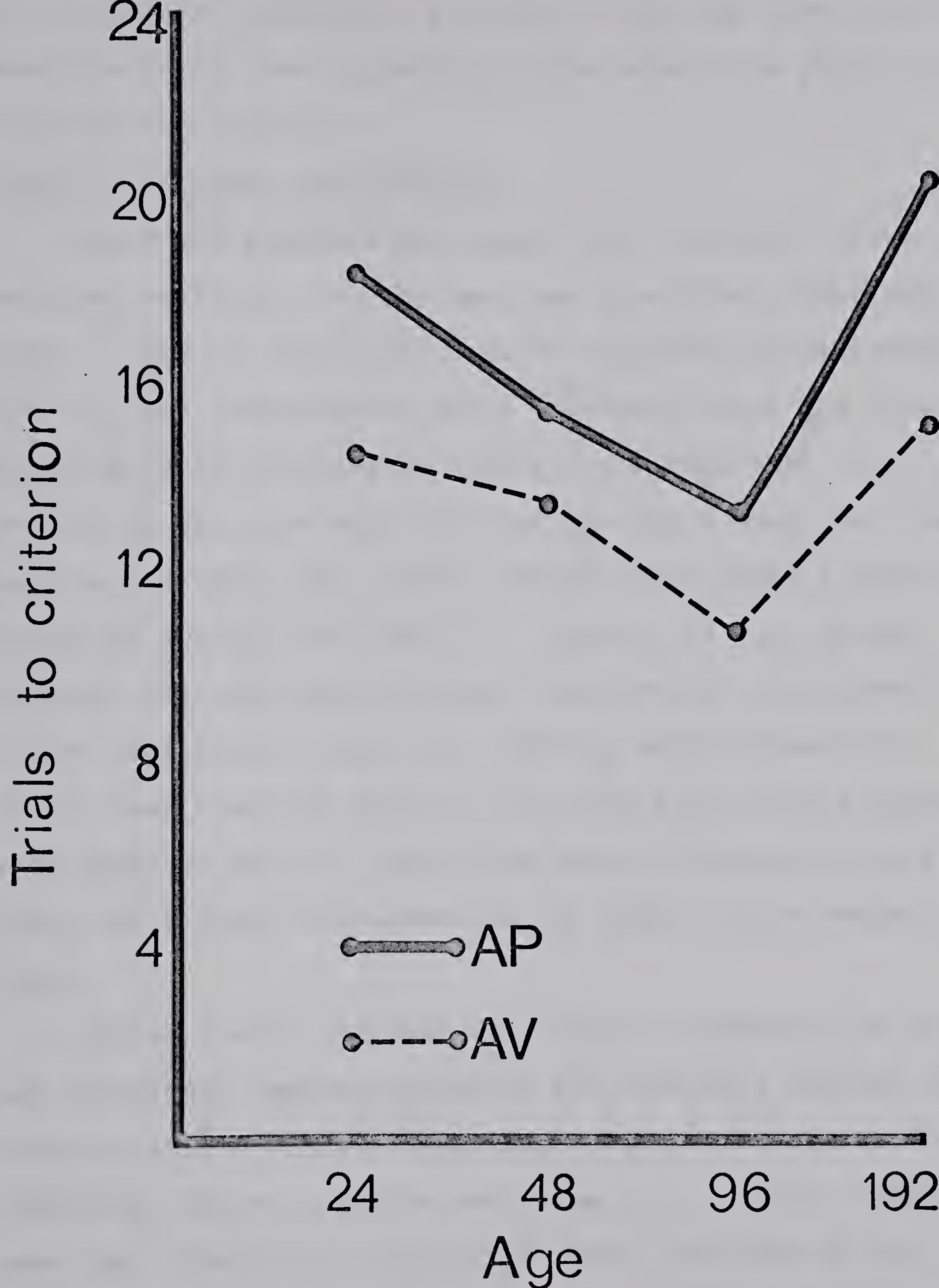


Fig.4. Mean trials to a criterion of three consecutive responses at speeds above 20.

the motivation dimension, although at all age levels the aversive groups were superior to the appetitive groups in reaching the criterion.

PASSIVE AVOIDANCE CONDITIONING.

Means and standard deviations for the speed scores recorded on Trial 1 of the last day of active conditioning (Day 6), and on Trial 1 of passive avoidance conditioning (Day 8), are presented in Table 6. These means are also graphically represented in Figure 5 and show that with respect to age, the rank order of the Day 6 means was the same as the rank order of the overall mean speed scores for the shock groups (see Table 2). Within the food groups however, the rank order of Day 6 and overall mean speeds differ somewhat, in that the 192AP Ss which showed the lowest mean speed on Trials 1-23, showed the second highest mean speed on Day 6. Apart from this discrepancy, the other three Day 6 means correspond to the order of the overall means.

Tables 2 and 6 further show that, in general, on the age dimension, passive avoidance was inversely related to the strength of the original learning. Within the aversive condition the best passive avoidance, i.e., lowest speed mean, was shown by the 192 day animals, followed by 24, 48, and 96 day old animals. Within the appetitive condition the 192 day old Ss also showed the best passive avoidance scores, followed by 24, 96, and 48 day old groups, in that order.

Table 7 shows the results of two 4 x 1 analyses of covariance (covariant was the data for Trial 1, Day 6) that

TABLE 6

Group means and standard deviations of speed scores (n=10) for Trial 1 of Days 6 and 8.

	Day 6		Day 8			Day 6		Day 8	
Group	x	s.d.	x	s.d.	Group	x	s.d.	x	s.d.
24AP	51.78	22.91	17.88	22.78	24AV	26.30	18.95	71.46	65.36
48AP	113.44	72.30	66.51	89.33	48AV	104.73	128.17	166.93	128.94
96AP	69.52	61.28	37.36	82.27	96AV	113.39	125.43	187.13	173.18
192AP	85.54	74.60	1.01	.42	192AV	64.31	81.33	59.94	65.62

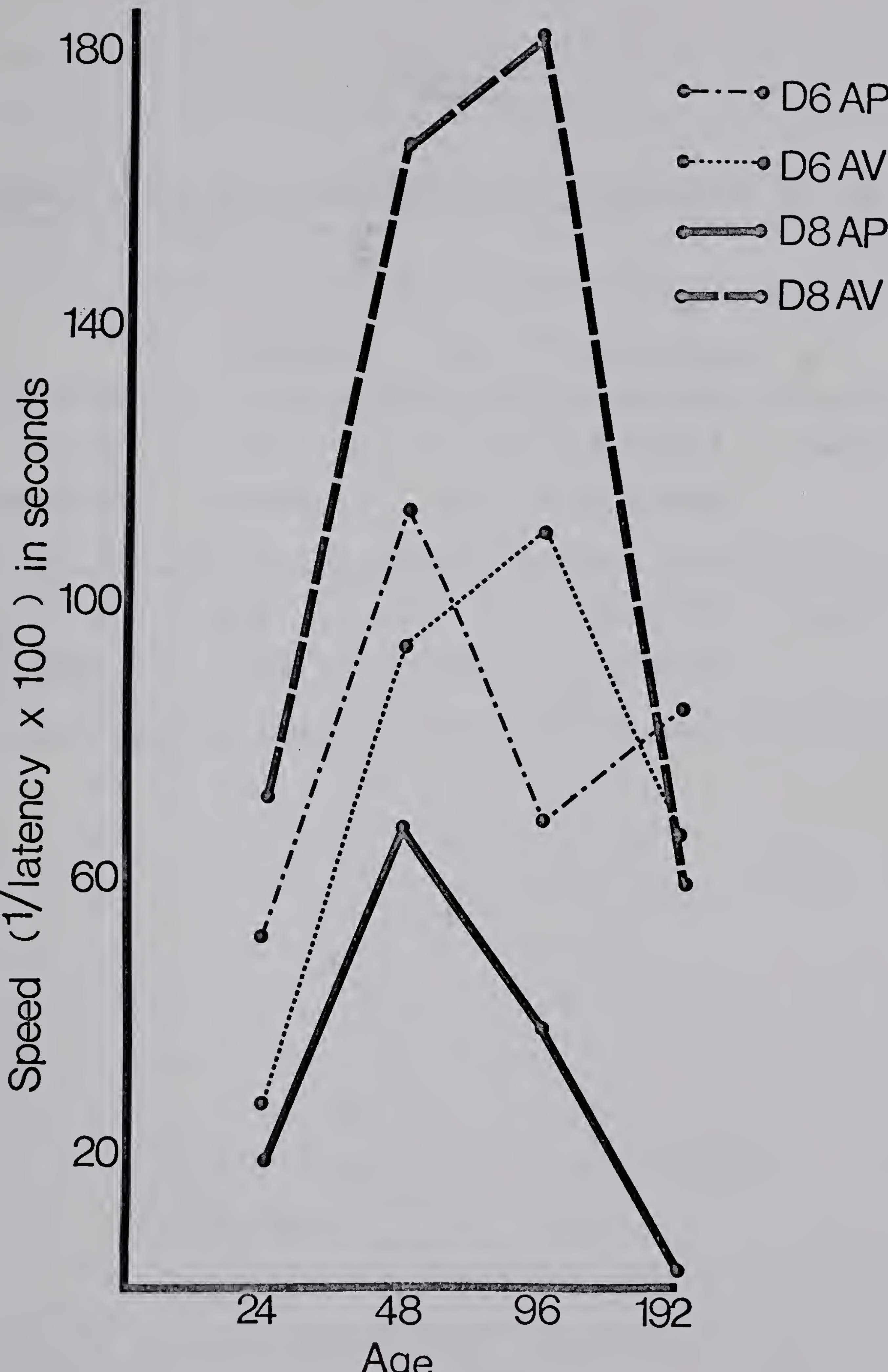


Fig.5. Group mean speed scores (n=10) for Trial 1 of Days 6 and 8.

TABLE 7

Summary table of the two analyses of covariance for age effects in the day eight data.

	Source of variation	df	Mean Square	F	P
	age	3	5,644.43	2.14	N.S.
Appetitive	error	35	2,644.66		
	age	3	14,406.44	1.49	N.S.
Aversive	error	35	9,755.69		

were computed for the passive avoidance performance in the aversive and the appetitive treatment groups. No significant age differences were indicated within either of the motivation conditions from this analysis (F=1.49, df= 3/35, p <.05; F=2.14, df=3/35, p <.05, respectively).

Reference to Table 6 shows that with respect to motivation, the speed means on Trial 1 of Day 6 for the aversive and the appetitive treatments were the reverse of the overall speed means, i.e., on Day 6, animals in all but the 96 day old group in the appetitive treatment were performing better than their aversive group counterparts, whereas the overall mean speed scores showed the aversive group animals performing better than the appetitive group Ss at all four age levels.

Table 6 and Figure 5 also show that on Trial 1 of Day 8, Ss in the 24AP, 48AP, 96AP, and 192AP groups decreased their speed scores (showed good passive avoidance) as a result of the Day 7 procedure. Animals in the 24AV, 48AV, and 96AV groups increased their speed scores on Day 8 (showed an enhancement of the older active avoidance response), while the 192AV animals remained relatively unchanged as a result of the Day 7 procedure.

A series of four 1 x 1 analyses of covariance were computed to test the significance of the motivation effect the results of which are presented in Table 8. These analyses showed that the 24, 48, 96 and 192 day old groups

in the appetitive motivation treatment were significantly superior in passive avoidance to their aversive motivation counterparts ($F=13.9$, $df=1/17$, $p<.01$; $F=13.7$, $df=1/17$, $p<.01$; $F=4.7$, $df=1/17$, $p<.05$; $F=11.4$, $df=1/17$, $p<01$, respectively).

TABLE 8

Summary table of the four analyses of covariance for motivation effects in the day eight data.

Age	Source of variation	df	Mean Square	F	P
24AP	motivation	1	25,540.12	13.9	<.01
vs.	error	17	1,832.92		
24AV	total	18			
48AP	motivation	1	58,257.67	13.7	<.01
vs.	error	17	4,243.85		
48AV	total	18			
96AP	motivation	1	75,321.95	4.7	<.05
vs.	error	17	16,050.49		
96AV	total	18			
192AP	motivation	1	20,538.93	11.4	<.01
vs.	error	17	1,809.36		
192AV	total	18			

Discussion

Active Conditioning

<u>Age</u>. The results of this study indicated that under conditions of aversive motivation young adult animals at 96 days of age performed the "light-on-light off" discrimination task with the greatest proficiency, while the adolescent animals at 48 days of age performed second best, followed by the old adult and infant groups at 192 and 24 days of age, respectively. However, the only significant difference was the inferior performance of the 24 day old animals as compared to the three older aversive motivation groups.

On the basis of a literature review of the studies on the development of learning that had been made prior to the start of this study, an hypothesis was formulated to the effect that under conditions of aversive motivation the optimum age for learning under these conditions is somewhere between 50 and 100 days, with older and younger animals doing less well on the required task. Specifically, it was predicted that the 96 day old animals should learn best, followed by 48, 192, and 24 day old <u>Ss</u>. While it is clear that the rank order of the group means obtained from this study did support the expectations suggested by the literature review, the mean differences were not, in general, significant.

Although a superficial examination of the results of this aversive treatment suggests the tentative conclusion that in the learning of a discrimination task, infant rats of 24 days are significantly inferior to adolescent and adult groups, it must be pointed out that this effect was quite possibly attributable to "the conditions of aversive motivation" rather than to any immaturity of the mechanisms involved in the learning process which might be characteristic of rats at this relatively early stage of development.

It was observed during the course of the study that the infant rats appeared to find the experimental situation to be very traumatic. These animals were separated from their mothers at 21 days of age and housed alone in the laboratory cages out of sight of, or contact with their litter mates. This condition was an abnormal one since young rats raised in a typical environment live in very close contact with their mother and litter mates, often lying in a pile heaped on top of each other, presumably for the warmth and/or contact comfort that such a position affords. Following isolation, these animals were immediately placed on deprivation and a schedule of handling and pre-training in preparation for the experiment, which itself involved subjecting the animals to fairly intense and, therefore, possibly frightening and painful stimuli. At this time, the weanlings showed the typical symptoms of anxiety, i.e., urination, defecation, squealing, and strenuous attempts to

escape from the experimenter's hand, that might be expected under these circumstances and which were, in fact, observed in the three older groups of animals at the beginning of the study. However, the weanlings' distress did not decrease with time as it did in the older groups, but seemed to increase to a point where two of the animals became so debilitated that they had to be eliminated from the study. Table 1 shows that the 24 day old animals in the aversive condition had lower weight gain during the study than did their appetitive group counterparts, although the latter were on a more severe food deprivation schedule. The poor physical and "emotional" condition of these animals suggests then, that their performance on the learning task may not have been an accurate reflection of their learning ability. Perhaps the learning ability of weanling rats is not well developed at this age, indeed, the literature on the subject suggests that it is not, but the present data must be interpreted with a view to the possibility that high anxiety was a contributing factor to the poor performance of the weanling group.

In the appetitive motivation treatment there were no significant age differences at all, although the rank order of the mean speed scores suggests that the adolescent animal in the 48 day old group performed the learning task with the greatest proficiency, followed by the 96 day old adults, the infant group at 24 days old, and the old adults

at 192 days of age, in that order.

In spite of the non-significance of the differences between the age groups in the appetitive motivation condition, the rank order of their performance scores corresponds to the previously predicted outcome of the study faily well. After considering the relevant literature, an hypothesis had been formulated which stated that under conditions of appetitive motivation, learning ability would decrease with advancing age, and, considering the mean speed scores presented in Table 2 this appears to be the case, at least for the three oldest groups. However, the 24 day old animals which had been expected to perform the best, in fact performed very poorly. This might be a result of the experimental anxiety discussed above, or, on the other hand, it may be that the learning ability of this group was genuinely inferior to that of the adolescent and young adult groups in the task used here.

Although due consideration has been given to the rank order in which the experimental groups performed the required task under the two conditions of motivation, the fact remains that with one exception in the aversive group, this study failed to show the expected significant age differences under either drive condition. Since it does not seem reasonable to conclude from this that there are no age differences in learning ability, it only remains to examine why these differences were not apparent in the

present study.

One of the most obvious reasons for the paucity of significant data in this study was the very high variability of scores within the experimental groups (Table 2). Examination of the standard deviations and the raw data for the eight groups shows that not only were the animals within a particular group highly variable in the way they responded to the learning task, but many animals were inconsistent in the speed with which they responded from day to day, and even from trial to trial within a particular day. This high variability tended to increase the error mean square in the analysis of variance, thus making it difficult to achieve an acceptable level of significance when the differences between the various treatment means were compared.

The marked individual differences found within the experimental groups could be interpreted in support of the null hypothesis that there really are no age differences in learning ability between the groups, or on the other hand they could be attributed to the particular measure of performance, i.e., a time measure, that was used as the dependent variable for learning. It is possible that a speed score may have measured factors other than learning ability, for example, motor functioning. Young adult animals may have faster reflexes or a higher activity level than either very young or very old animals. Perhaps also,

animals respond to different cues at different ages, or even within a certain age level. For example, a particular group of animals, or certain animals within several groups, may develop some form of temporal conditioning. In this case these rats may be responding to the time interval between light onset and shock onset, rather than responding immediately to the "light on" stimulus itself. Such differences in response "strategy" within a group would also contribute to the variability of the group as a whole.

The suggestion that speed of response may not have been the best measure of learning ability brings up the learning vs. performance controversy. The question of interest for this study is the relationship between response speed and actual learning, and to what extent the former adequate reflects the latter. Because animals in a particular age group performed a learning task with a higher mean speed than animals in a different age group, does this necessarily mean that learning ability was also greater at that particular age?

Reference to Figure 3 indicates that in general, by the end of Day 2 of conditioning none of the aversive motivation <u>Ss</u> were receiving shock, i.e., <u>Ss</u> within all four age groups had learned to make the correct response within five seconds of the light onset, which is equal to a speed score of 20. Figure 3 suggests that in fact, the old adult group actually learned to make the avoidance response first even though their overall speed mean was lower than two of the other

groups. However, closer examination of the raw data indicates that this was not really the case. Analysis of trial means, rather than daily means, for the four groups shows that the mean speed scores had exceeded 20 first in the 96 day old group (Trial 3 of Day 1), then in the 24 and 48 day old groups (Trial 2 of Day 2), and finally the 192 day old animals (Trial 3 of Day 2).

Similarly, in the appetitive motivation groups, most of the animals at all four age levels were making speeds in excess of 20 by Day 4 of conditioning, although as with the aversive motivation groups, there were clearly differences in the actual speeds above this point at which the Ss performed the task at the various age levels. The animals in the 96AP and 48AP groups were making average speeds above 20 by Trial 1 of Day 4, in the 24AP group by Trial 3 of Day 4, and in the 192AP group by Trial 3 of Day 5.

When Scheffe's test was applied to the Trial Block means of Days 4,5, and 6 of the aversive groups it was found that on both Trial Blocks five and six 96AV was significantly superior to 24AV, but these were the only significant differences within this motivation group. Similar testing was carried out for the appetitive motivation groups but in this case no significant differences were apparent within the trial blocks. The analysis of variance summarized in Table 3 had shown significant Age x Trials and Motivation x Trials interactions which indicated

that there might have been more significant differences on trial blocks than the two that were found. However, the absence of significant differences in this analysis may have been partially due to the large overall error mean square that was used to test the means.

When the number of trials to a criterion of two or three consecutive correct responses was taken as the dependent variable for learning instead of the speed measure, 96AP was significantly better than 192AP, but apart from this no significant age differences were found in either the appetitive or the aversive motivation groups. The rank order of these means was the same within both motivation groups, i.e., the best performance was shown by the 96 day old Ss followed by 48, 24, and 192 day old Ss. This pattern was similar to the overall rank order of the mean speed scores within both the aversive and appetitive treatments in that the two middle ages performed best, with older and younger groups of animals performing less well on the task. However, there was a discrepancy between the trials to criterion data and the overall speed means in that when the latter was taken as the criterion for learning, in the appetitive motivation group the 48 day old level appeared to be the optimum age for learning rather than the 96 day level that was dominant in the trials to criterion analysis.

It is also possible that significant age differences would have emerged if a wider age range of animals had been

tested, particularly at the upper age levels. Possibly the age groups chosen for this study sampled only infant and young adult populations, and that additional groups taken from old adult levels would have produced a more marked age effect.

Another possible explanation for the failure to demonstrate significant age differences might be related to the fact that animals at the four age levels were probably not all equally motivated. However, this point will be discussed below.

Motivation. Analysis of the mean speed scores for the eight groups revealed that at all four age levels, animals that performed the discrimination task under conditions of aversive motivation did so faster than did comparable animals that performed the same task under conditions of appetitive motivation. However, when Duncan's New Multiple Range Test was applied to the data it was found that only the 96 and the 192 day old animals were significantly different on the motivation dimension.

However, it is somewhat difficult to conclude from the results of this study that learning ability is affected by, or develops differentially with, the kind of motivation under which the animal is operating, even at the adult stages of development where significant differences between motivational conditions were obtained.

For example, in the planning stages of this study it became apparent that the motivating stimuli of hunger and shock or fear were perhaps not of equivalent aversive strength, and further, that within the food deprivation and shock treatments, animals at the various age levels were not being equally effected by shock intensity and food deprivation. An attempt was made to equalize motivation both within each of the two drive conditions and between shock and food groups at the four age levels by varying the shock or food deprivation strength according to the animal's age, i.e., the older the animal the smaller was his daily food ration, and similarly, older animals received slightly stronger shock than did the younger animals. Also, both food deprivation and shock stimuli were "strong". However, there was reason to suspect that this attempt to equalize motivation was not entirely successful, since the data presented in Table 1 show that neither the Ss in the aversive motivation groups nor those in the appetitive motivation groups were at the same percentage of the body weight of their respective control animals.

Perhaps it is not possible to equate motivation across age groups. Old animals may have duller sensory apparatus than younger animals, for example, and even within a certain age group there may be individual differences in both threshold and responsiveness to painful stimuli, be they hunger or shock. If this were true to any great

extent it would probably be a contributing factor to the extremely high within group variability that was observed. Muenzinger and Mize (1933) tested a method for shocking animals which held skin resistance roughly constant and determined thresholds for reactions to electric shock, and they found significant differences in the threshold levels of their rats, both within and between the age groups tested.

There has been very little work done on the problem of quantitatively scaling the stimulus properties of shock. It is usually considered adequate in research to establish that an animal's motivation can be related by an ordinal scale to some dimension of physical intensity, for example, that an animal experiencing a 2 ma. current is more motivated than an animal experiencing a 1 ma. current. However, Bolles and Williams (1965) found that some animals could learn certain characteristic modes of adjustment to gain at least partial relief from shock. They observed that when constant current shock was used Ss would freeze and hol tight to the electric grid, thus decreasing the skin resistance and the voltage drop across their bodies, and when a constant voltage shock source was used some animals would step lightly and jump around thereby maximizing skin resistance and decreasing the current flow.

Another aspect to the problem of the quantification of drive produced by shock is the measurement of fear by trying it to its antecedent conditions, since fear is usually introduced ad hoc, its occurrence being assumed from the behavior it is introduced to explain. It appears that while it is possible to quantify shock it is not really possible to measure the pain and fear produced by shock, at least not at this time.

The accurate measurement of hunger is not without its difficulties either. For example, Campbell and Williams (1961) found that in order to quantify the drive state produced by food deprivation the age of the animals must be taken into consideration. They found that over a period of 12 days on a food deprivation schedule on which groups of animals at 23, 38, 54, and 100 days of age were given the same quantities of food, that the younger the animal the greater was his daily percentage weight loss as compared to older animals.

The obtained results on the analysis of the motivation main effect in the present study did not correspond to those which had been predicted prior to the start of the project. It had been expected that the study would show the 24AP animals performing significantly better than the 24AV animals, that neither 48AP or 96AP animals would differ significantly from their respective aversive group

Ss and that the 192AV rats would be significantly superior to the 192AP rats. These predictions were supported by the data only in the 48 and 192 day old groups.

However, if it was true that motivational strengths were unequal as Table 1 suggests, then there may be some justification for transforming the entire appetitive group curve of Figure 1 by arbitrairly raising it by a value lying between the two difference scores of the 48 and 96 day old animals. From Table 2 it can be calculated that the 48AV and 48 AP mean speeds differ by a score of 21.27, and similarly that the 96AV and 96AP mean speeds differ by a score of 49.62, and further, that the mean of these two differences is 33.45. If then, the entire food group curve of Figure 1 is raised by the value 33.45 then 24AP will be superior to 24AV, 48AV and 48AP will be performing similarly, 96AV and 96AP will also be performing similarly, and 192AV will still be superior to 192AP.

Assuming that this transformation is acceptable, there is then some support from Schneirla's suggestion that seeking patterns of behavior are mastered out of approach behavior before withdrawal reactions habe begun to differentiate into avoidances. What this means in relation to the present study is that the 24 day old rats performing a learning task under conditions of appetitive motivation should be superior to a group of 24 day old animals performing the same task under conditions of

aversive motivation, and this would be the case in the present data if the transformation described above is applied.

However even if the data are considered in their original form there is still some evidence to support Schneirla's idea since the difference between 24AV and 24AP was not significant and this difference was also the smallest in the four age groups. Perhaps then, at this age withdrawals have not yet, or perhaps are just beginning to differentiate into avoidances. If it had been possible to have used a group of younger animals in the study these Ss might have performed the task significantly better under appetitive than aversive motivation conditions.

The results of this study did not generally confirm the expectations that had been stated prior to the start of the research since significant differences in learning ability along both age and motivation dimensions were few. However, the rank order of the obtained performance scores corresponded very well to those that had been predicted suggesting that had the various methodological difficulties discussed above been overcome, the predicted and obtained results would have been more in accord. As it is, both the shock and food curves across age groups showed an inverted-U function with the middle age groups learning better than either younger or older groups and

with optimum age for learning being younger in appetitive treatment condition than in the aversive motivation group. The present study also showed that in general, given the parameters of this study, shock group animals learned the discrimination task better than did their food group counterparts. However, this superiority of shock over food animals was significant only at the upper two age levels.

Passive Avoidance Conditioning

Age. The results of this section of the study indicated that in general, with respect to age, the ability to learn passive avoidance under the conditions of this study, seemed to be inversely related to the strength of the original learning. The analysis of the data showed that within the aversive motivation condition, although the Ss really did not passively avoid, the 192 day old animals showed the lowest speed scores (best "passive avoidance"), followed by the 24, 48, and 96 day old Ss. The animals in the appetitive motivation groups showed good passive avoidance on Day 8 with the 192 day old rats performing best, followed by the 24, 96 and 48 day old rats in that order.

These results are clearly the reverse of the pattern of the overall trial means (see Table 2) and the means of the groups on Trial 1 of Day 6 (see Table 7), in that animals in the middle two age groups showed poorer passive avoidance

scores than the younger and older groups. However, an analysis of covariance computed for the data did not indicate that any of the age differences in performance in either of the motivation conditions were significant.

Motivation. The analyses of covariance for the motivation effect indicated that on Day 8, the passive avoidance scores in all four appetitive groups were significantly better than the passive avoidance scores of the four aversive motivation groups. This pattern of results was the opposite to that found in the overall trial means of the original learning, where the aversive motivation groups performed better than the appetitive motivation groups at all four age levels.

It appears from Figure 5 that the aversive motivation groups actually did not passively avoid at all, but in fact, at the 24, 48, and 96 day levels showed a marked increase in their speed scores as a result of the Day 7 procedure, while the 192 day old Ss remained relatively unchanged from Day 6 to Day 8.

It appears that the effect of the Day 7 procedure on the aversive motivation groups was one of "enhancing" the original learning. Since these groups had been successfully avoiding shock since Day 2 of active conditioning, the new shock which occured on Day 7 acted as a stimulus for the increased speed scores, perhaps by increasing the Ss

anxiety. Thus, these data fit in with the idea of Solomon and Wynne (1954) that when animals experience intense trauma as the unconditioned stimulus the classical conditioning of emotional responses is partially irreversible. They say that once an organism is avoiding the US regularly and is thus not receiving any traumatic stimulation, it is meeting the conditions believed to be required for extinction, and it would be expected that according to Pavlovian laws the conditioned anxiety reaction would gradually extinguish. This in fact does not appear to happen, and reintroduction of the traumatic stimuli long after it has "extinguished" produces a rate of avoidance responding far in excess of what would have been expected had the anxiety reaction actually been extinguished.

In summary, the results of this study suggest the following general conclusions:

1.) When groups of rats learned a discrimination task under conditions of either aversive or appetitive motivation, adolescent and young adult groups learned faster than either infant or old adult animals. However, the optimum age for learning seemed to be slightly younger in the appetitive groups as compared to the aversive groups, i.e., adolescent rats learned better in the former condition, and young

adults were superior in the latter.

2.) Rats which learned the discrimination task under aversive motivation were superior at all age levels to those rats learning the same task but under appetitive motivation conditions.

3.) When active conditioning trials were followed by training in passive avoidance, animals which had learned the initial discrimination task under appetitive motivation showed good passive avoidance, whereas the animals who had originally learned under aversive motivation did not passively avoid. Instead, the new shock which occured on Day 7 seemed to enhance the original learning of these animals.

4.) With respect to age, the rank order of the passive avoidance scores was, in general, inversely related to the strength of the original learning.

5.) The results of the study did not provide strong support for Schneirla's Approach - Withdrawal theory. However, when the data are interpreted in view of the probable inequality of motivational strengths, it then becomes conceivable that, as Schneirla suggested, seeking patterns of behavior were mastered out of approach responses by young animals before withdrawal reactions had begun to differentiate into avoidances.

References

Biel, W. C. Early age differences in maze performance in the albino rat. _J. genet. Psychol._, 1940, 56, 439-453.

Birren, J. E. Age differences in learning in a two choice water maze by rats. _J. Gerontol._, 1962, 17, 207-213.

Bolles, R. _Theory of motivation_. New York: Harper & Row, 1967.

Campbell, B. A., Teghtsoonian, R., & Williams, R. A. Activity, weight loss, and survival time of food deprived rats as a function of age. _J. comp. physical. Psychol._, 1961, 54, 216-219.

Denenberg, V. H., & Kline, W. The relationship between age and learning in the rat. _J. comp. physiol. Psychol._, 1958, 51, 488-491.

Doty, B. A. Age and avoidance conditioning in rats. _J. Gerontol._, 1966, 21, 287-290.

Fields, P. E. The age factor in multiple discrimination learning in the rat, _J. comp. physiol. Psychol._, 1953, 46, 387-389.

Hubbert, H. B. The effect of age on habit formation in the albino rat. _Behav. Monogr._, 1915, 2, 1-55.

Key, H. & Sime, M. Discrimination learning with old and young rats. _J. Gerontol._, 1962, 17, 75-80.

Kirby, R. H. Acquisition, extinction, and retention of an

REFERENCES

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

avoidance response in rats as a function of age. *J. comp. physiol, Psychol.*, 1963, 56, 158-162.

Liu, S. Y. The relationship of age to the learning ability of the white rat. *J. comp. Psychol.*, 1928, 8, 75-85.

Muenzinger, K. & Mize, R. The sensitivity of the rat to electric shock: Thresholds & skin resistance. *J. comp. Psychol.*, 1933, 20, 85-93.

Munn, N. L. *Handbook of psychological research on the rat.* New York: Houghton Mifflin, 1950.

Oldfield-Box, H., & Key, H. Four choice visual discrimination tasks in the formation of learning sets by rats. *Anim. Behav.*, 1962, 11, 518-521.

Ramond, C. K. Carlton, P. L., & McAllister, W. R. Feeding method, body weight, and performance in instrumental learning. *J. comp. physiol. Psychol.*, 1955, 48, 294-298.

Schneirla, T. C. An evolutionary and developmental theory of bophasic processes underlying approach and withdrawal. *The Nebraska symposium on motivation*, 1959, 7, 1-37.

Sime, M. E. & Key, H. Interproblem interference and age. *J. Gerontol.*, 1962, 17, 81-87.

Solomn, R. L., & Wynne, L. C. Traumatic avoidance learning: The Principles of anxiety conservation and partial irreversibility. *Psychol. Rev.*, 1954, 61, 353-383.

Solyom, L., & Miller, S. The effect of age differences on the acquisition of operant and classically conditioned

responses in rats. _J_. _Gerontol_., 1965, 20, 311-314.

Stone, C. P. The age factor in animal learning: 1. Rats in the problem box and the maze. _Genet_. _Psychol_. _Monogr_., 1929, 5, 1-130 (a).

Stone, C. P. The age factor in animal learning: 2. Rats in the multiple light discrimination box and a complex maze. _Genet_. _Psychol_. _Monogr_., 1929, 6, 125-202 (b).

Thompson, R. W., Koenigsberg, L. A., & Tenneson, J. C. Effects of age on learning and retention of an avoidance response in rats. _J_. _comp_. _physiol_., 1965, 60, 457-459.